ADSORPTION OF ORGANIC SUBSTANCES BY PLANTS AS RELATED TO PLANT RESPIRATION

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After the capacity of tissues of higher plants to adsorb enzymes had been discovered and a method of determining the adsorptive capacity proposed [1, 2], a number of papers dealing with the significance of the phenomenon in question for the regulation of enzymatic processes in cells was published [3, 4, 5, 6, 7]. It was established that the capacity to adsorb invertase is lost by aged and dying tissues [2]. Analogous results had already been obtained in the instance of yeast [8]. It became clear that a biological function of living protoplasm was involved rather than simple adsorption. The ability of plant tissues to adsorb substances from external solutions is not limited to enzymes, but extends to other organic substances. This was already known as far as invertase is concerned, but has been found to apply to glucose, sucrose, and glycine as well. In the series of experiments described at present, it was found that sucrose is adsorbed by Cyclamen leaves to a much greater extent than glucose: the quantity is 2-3 times greater. This result emphasizes the selective character of the adsorption and, on the other hand, shows that there is no connection with the permeability of protoplasm. Glycine and several other amino acids are adsorbed to a still

greater extent than sucrose, which is probably connected with the ionic character of this class of substances. Similar results were obtained in experiments with other tissues of higher plants: Cyclamen leaves are a typical example. When the concentration of oxygen in the external solution is reduced, the adsorption of organic substances drops noticeably. In evaluating this effect, one must bear in mind that oxygen, owing to its low solubility in water, penetrates into living cells only very slowly. Oxygen is used up rapidly in the cell and a considerable difference between the partial pressures in the cell and in the external medium results. The intensity of respiration and the respiration quotient of higher plants remain unchanged down to a content of 3-5% of oxygen in the outer atmosphere. Respiration is affected only when the partial pressure of oxygen drops below that value [9]. One must assume that the actual pO_2 at which the living protoplasm functions is much lower than the apparent oxygen pressure corresponding to the content of that gas in the external medium. Under the circumstances the influence of oxygen on the adsorption of organic substances can be demonstrated much more convincingly by varying the pO_2 in the cells rather than in the external medium. In view of the fact that illumination promotes evolution of oxygen in green cells, the oxygen content of cells can be regulated much more precisely by illuminating them at various oxygen pressures. Experiments along these lines demonstrated that adsorption is increased by illumination in the case of all tissues containing chlorophyll, while application of light was without effect on the respiration of colorless tissues. The action of light is most pronounced whenever the supply of oxygen is low; thus, adsorption of glycine was found to be higher under illumination with a low supply of oxygen than in the dark with a normal supply of oxygen. The magnitude of the effect produced by illumination depends on the concentration of carbon dioxide in the external medium (the solution).

In addition to Cyclamen leaves, actual measurements of adsorption were carried out on barley sprouts, Potamogeton leaves, sugar beet roots, and Cyclamen tubers. Adsorption of the organic substances is accompanied by a rapid but short lived (15-30 min.) rise in respiration; this furnishes to the cells the necessary energy for the adsorption process.

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